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## UNITED STATES NAVY AWARDS

IN the whole world there is probably not a more exacting consumer or a more careful buyer of lubricating oil than the navy of Uncle Sam. The intricate power plants of the great dreadnaughts, the torpedo boat destroyers, the motor boats, the submarines and aeroplanes require the most perfect lubrication. Pondering over the many types of engines and bearings, the manifold difficulties to be met, and the results that must be obtained in order that the battleship or the submarine or the aeroplane may not fail at the critical moment, one must be profoundly impressed, with the lubricants which have successfully met such unusual tests.

The navy purchases its lubricants upon a competitive basis. Great emphasis is laid upon the fact that none but the highest quality of lubricating oils will be considered under any item of their schedule. The oils which are submitted are subjected to the severe tests. They are first tested at the Naval Experiment Station at Annapolis in a specially constructed testing machine designed to duplicate as nearly as possible the actual working conditions. They are then tested from every possible angle in the laboratory, and those which survive these tests are actually installed in the battleships or motors and given a preliminary try-out. The contracts are awarded from the results of all these tests combined.

In the recent awards the Navy Department, Bureau of Supplies and Accounts, called for the following deliveries for both Atlantic and Pacific ports:

1. Engine Oil for main engines.
2. Engine Oil for main engines with forced feed lubrication.
3. Dynamo Oil.
4. Cylinder Oil.
5. Oil for ice machines, air compressors and pneumatic tools.
6. Engine Oil for turbines.
7(a). Motor Cylinder Oil for general use, heavy.
7(b). Motor Cylinder Oil for general use, medium.
7(c). Motor Cylinder Oil for general use, light.

We feel justly proud of the fact that the contract for all of these items was awarded to The Texas Company. This is by no means the first experience of The Texas Company with the U. S. Navy. Such battleships as the *New York*, *Texas* and *Florida* are now being lubricated with our oils, and on some of the ships our oils have been used for several years. Nor is the use of Texaco Oils confined to the U. S. battleships, for the *Rivadavia*, the largest battleship of the Argentine Navy, uses Texaco Ursa Oil for her main turbines, and Texaco Cetus Oil for her auxiliaries.

The oils accepted by the navy for items 1 to 7 are as follows:

**Items**

1. Texaco Neptune Marine Engine Oil.
2. Texaco Ursa Oil.
3. Texaco Cetus Oil.
4. Texaco Pinnacle Mineral Cylinder Oil.
5. Texaco Spica Oil.
6. Texaco Cetus Oil.
7 (a). Texaco Ursa Oil.
7 (b). Texaco Alcaid Oil.
7 (c). Texaco Cetus Oil.

Texaco Ursa Oil accepted by the navy for the marine engines with force feed circulating systems, for the heaviest turbines, and for heavy gasoline motor engine oil for motor boats, submarines and aeroplanes, is one of the leading Texaco products. It is a pale filtered, straight mineral oil of high viscosity, and with practically a zero-cold test. It will not saponify or form an emulsion when mixed with water, but, on the contrary, separates from the water very readily.

In addition to such uses as those enumerated above, Texaco Ursa Oil is without an equal for the lubrication of large Continental Type Diesel engines, Brown-Diesel engines, gas engines requiring a heavy-bodied lubricant, heavy machines, printing presses, high-pressure air compressors, water wheel governors, and in fact, wherever a high-grade, heavy-bodied lubricant is desired. There is no lubricant on the market that can compete with Ursa. It has been used under so many difficult conditions, with such unusual results, that it is impossible for us to write about it without becoming enthusiastic. Fortunately, however, the success and popularity of Ursa in the U. S. Navy speaks so eloquently of its efficiency as a lubricant that it is unnecessary for us to do more than simply refer to some of the cases in which it has been used.

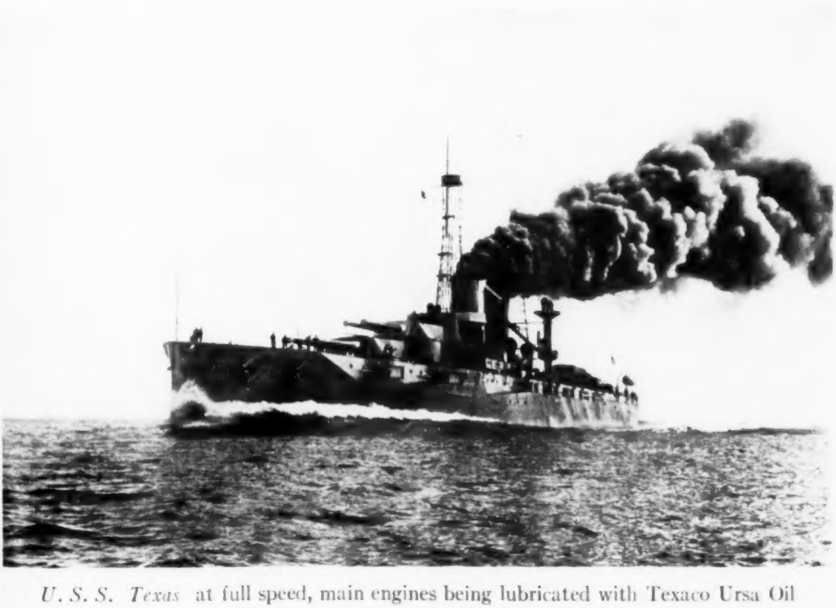
The *U. S. S. Delaware* was the first ship built for the navy with a force feed lubricating system. Her first trials were made on a competitive oil which was supposed to be especially adapted for force feed lubrication. However, it formed an emulsion with the water that leaked by the stuffing boxes, and a second lot of oil from the same firm was installed. During the first run with this lubricant water was turned on a number of the main bearings and the ship was laid up for twenty-four hours in order to re-cut some oil ways in the caps of the main bearings. After the ship was turned over to the Government the bearings were examined; the shaft was found to be in a very bad condition, and the oil in the system was very badly emul-

sified. A heavy deposit had also formed on the bearings, on the shaft, and in the pipes and tanks. The entire lot of oil was removed and Texaco Ursa Oil was placed in the system in July, 1910. During the next two years the *Delaware* steamed more than fifty thousand miles without a hot bearing. At one time during a storm the engines operated on a mixture of half sea water and half oil, without damage to the engines or to the oil.

The *U. S. S. Florida* likewise had considerable trouble with her oiling system, with the result that the paraffine oil which was being used was finally taken out of the system and a supply of Texaco Ursa Oil was installed in February, 1912. The lubricating system which had given so much trouble with the other oil was in no way changed, and the bearings remained untouched. With the Ursa Oil the ship ran from Guantanamo Bay to New York without a hot bearing, in spite of the fact that the bearing surfaces were in a bad condition, and since the installation of the Ursa Oil the *Florida* has had no further bearing trouble.

In 1911 the *U. S. S. New Hampshire*, also using Ursa Oil, shipped a large quantity of sea water during a trip to England. It was necessary for them to run a number of days with a mixture of half sea water and half oil, and again, as in the case of the *Delaware*, this feat was accomplished without any damage to the ship's bearings or to the oil.

During the preliminary trials of the modern thousand ton torpedo-boat destroyer, the *U. S. S. Henley*, bearing trouble developed in the reciprocating engines and turbines. The oil was pumped out, the bearings were re-babbitted and Texaco Ursa Oil placed in the system. With this oil the ship completed her trials and was turned over to the Government. Later the Ursa Oil was taken out of the system and the competitive oil installed. Serious difficulty again developed with the bearings, and it was found necessary to remove for the

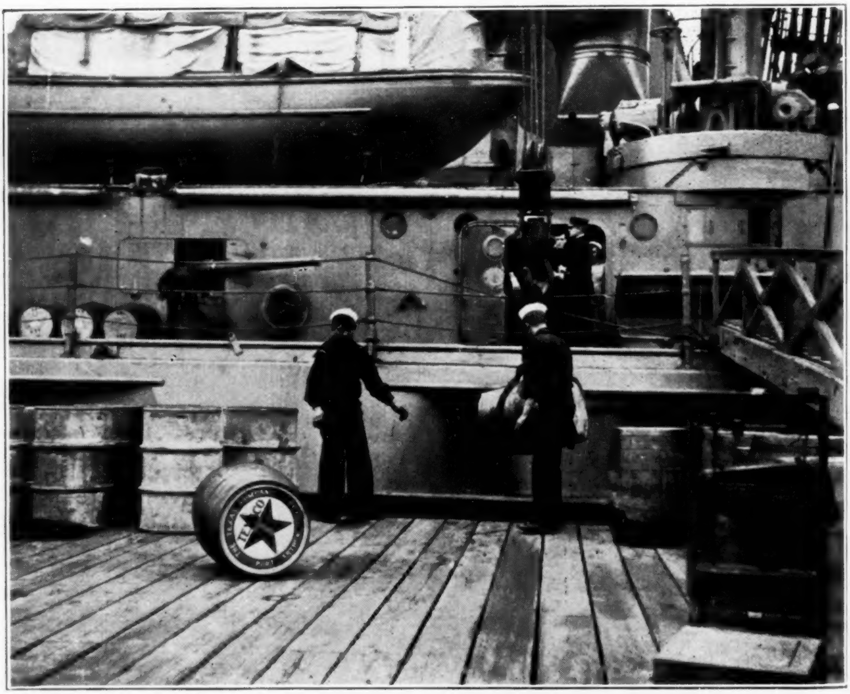


*U. S. S. Texas* at full speed, main engines being lubricated with Texaco Ursa Oil

second time from the system the oil which had been contracted for. The bearings and shaft were repaired, and Texaco Ursa Oil once more placed in the system in July, 1913. During the high-speed trials which took place during November, 1913, the *Henley* developed the speed of 30.3 knots per hour without the slightest indication of bearing trouble. At the conclusion of all the trials an examination of the thrust bearings showed that the rings were bright, and without any appearance of wear or corrosion. Owing to the peculiar type of this ship, water gets into the circulating oil. This water very readily separates from the oil, without causing the least damage.

In the case of the new battleship, the *U. S. S. Texas*, the shipbuilders' trials, which took place in October, 1913, were made with Texaco Ursa Oil on the port side and a competitor's oil on the starboard side. During the speed trials it was found that the competitor's oil evaporated, filling the engine room full of vapor, and that the oil formed such an emulsion with the water as to render a separation of the oil and water almost impossible. During the runs, and before the endurance trial, it was found necessary to pump the competitor's oil overboard, and to place Texaco Ursa Oil in the whole system.

In the case of the *U. S. S. New York*, no other oil than Texaco has ever been through the circulating system. For the dock trials, beginning March 2, 1914, Texaco Ursa Oil was installed in the oiling system and tanks. When



Scene at Boston Navy Yard. *U. S. S. Nebraska* taking on stores for active service in Mexican Waters

the *New York* was hastily put into commission on account of the Mexican situation, she sailed out of the New York Harbor on April 27th for Vera Cruz stocked up with Texaco Ursa and Cetus Oils, without having had the customary preliminary running-in of her bearings. The ship made its trip to Vera Cruz without any bearing trouble whatever, demonstrating that with Ursa Oil it was not essential for the ship to have the regular preliminary runs to get her bearings in shape. The final trials have not yet been held, but are to take place off Rockland in the near future. For these runs an additional order for Texaco Ursa Oil has been received.

Texaco Cetus Oil, accepted on the navy contract for a dynamo oil, turbine oil and as a light-bodied motor cylinder oil, is already very well known in the navy, as it has been on the navy contracts as a turbine oil for three years. This fact in itself is sufficient recommendation for the oil. It is a pale, filtered light-bodied straight mineral oil with a cold test of zero degrees Fahrenheit. Like Ursa Oil, it leaves no deposits upon the bearings. Whatever deposits are formed in the motor cylinders or on the piston heads are light and fluffy and can be easily removed, while the deposits from most oils are hard and flinty and must be removed by chipping or by some special treatment. Texaco Cetus Oil will operate successfully in every kind of circulating system, and like Ursa Oil, will readily separate from water.

Texaco Alcaid Oil, which was accepted for the medium motor cylinder oil, is also a straight mineral oil, with a viscosity higher than that of Cetus and below that of Ursa. It belongs to the same family as these two oils, and like them, has a zero cold test, and what little carbon is deposited in the motor is soft and easily removed.

Texaco Spica Oil, which is to be used by the navy for ice machines, air compressors and pneumatic tools, also belongs to the same family as Cetus and Ursa, in fact is made from the same crude. Spica is the lightest in body of all of these oils, and remains liquid at a temperature far below zero. In addition to the uses to which it is to be put in the navy, this oil is especially adapted to the lubrication of light, high-speed machinery, and is the best spindle oil on the market. Most oils, when used on spindles, tend to leave a deposit in the spindle bases. The Spica Oil leaves no deposit when used for this purpose.

Texaco Marine Engine Oil, which is to be used by the navy for main engines, is a compounded oil, made to saponify with water so that when the oil comes in contact with water it will form an emulsion which will stick and lubricate. This is intended for the lubrication of reciprocating engines where the oiling is done by hand or through wick-feed or drop oilers. This is also an excellent lubricant for the foot-step bearings of water-wheels and water turbines; in fact, for any conditions where the bearings may come in contact with water.

Texaco Pinnacle Mineral Cylinder Oil is the cylinder oil adopted by the navy for steam cylinder and valve lubrication. This is a heavy, dark-colored cylinder oil, possessing fine lubricating qualities, and will be used under all steam conditions.

In conclusion it might not be out of place to refer to the fact that the bids of The Texas Company for the Fuel Oil for practically every item have also been accepted by the U. S. Navy. In the course of a year the navy uses more than a million barrels, or about half a billion pounds of Fuel Oil, and practically every barrel of this during the next year, is to be supplied by The Texas Company.

# GOOD LUBRICATION—THE MOTOR CONSERVER*

## Motor Oil in a New Light

CONSERVATION measures are always the least understood and the last to be investigated. It is, therefore, to be expected that comparatively little study should have been given to the question of lubrication except in the oil business, and only a partial study has been given to it even in that business. Primarily because the study of lubrication in the oil business has been from the standpoint of determining the best way to market certain oils and not always from the standpoint of arriving at the most efficient means of lubricating. This is, of course, to be expected. It does not, however, excuse the engineer who is interested in motor lubrication from the criticism which the neglect of this important subject rightly subjects him to. Little, if any, attention has been paid by the automobile engineer (until the last two years) to the factors which enter into and affect the efficiency of lubrication, and where these factors have been taken into account by the oil manufacturer they have been considered only as exercising a controlling influence upon the character of the oil required. Whereas, it is entirely probable that the character of the oil adapted to the work is not materially affected by the changes in the design of the motor, the lubricating system or other conditions, but rather these conditions have an effect upon the final efficiency of any lubricating oil which is used.

Moreover, where attempts have been made to scientifically consider the character of the oil necessary for efficient lubrication, the conclusions reached and the deductions made from such consideration generally show either a partial knowledge of the conditions in the oil business and the requirements of the motor, or a neglect of some of the factors entering into the case. It is not many years ago that gasoline of high gravity was considered necessary to secure any power, although now it is generally understood that a lower gravity gasoline means greater power and more mileage per gallon and that gravity may change in the gasoline produced from different crudes without affecting the starting value or volatility of the product. These later developments have shown definitely that the characteristics by which the general public (and even the trained engineer) have been used to measure gasoline have little, if any, bearing upon its value as a motor fuel.

### Physical Tests are Not Always Final

It is now understood by some oil experts (who have conducted their researches very carefully into the conditions in a number of oil fields and conditions in the motor business) that some of the physical characteristics of lubricating oil which are generally quoted as being synonymous with good lubrication, have little to do with the mechanical efficiency of the lubricating oil under working conditions. In this respect oil values are much like creeds and political traditions, the old habits of expression remain long after the deficiencies are known.

Many years ago, when the crude oil all came from the same part of the country and possessed practically the same characteristics, chemical composition, etc., it was a comparatively easy matter to determine whether a uniform oil of uniform

*Reprint from *Scientific American*, January 3, 1914.

value was being secured. Consequently, the crude oil from which the lubricants were taken at that time passed into the standard, and the general physical characteristics were used as expressing the standard of requirement. Later discoveries in oil fields have shown that, like all natural products, oil varies in its chemical and physical characteristics, according to the deposit, and these varying deposits cannot be measured solely by the values established by the characteristics of one field. On account, therefore, of the absence of any valuable standard of comparison in the oil business, and the conflicting opinions which have developed in the study of motor lubrication, the only way to properly consider this subject is to ask what the requirements are and see what qualities are necessary to fulfill them.

### How Lubrication Affects Compression

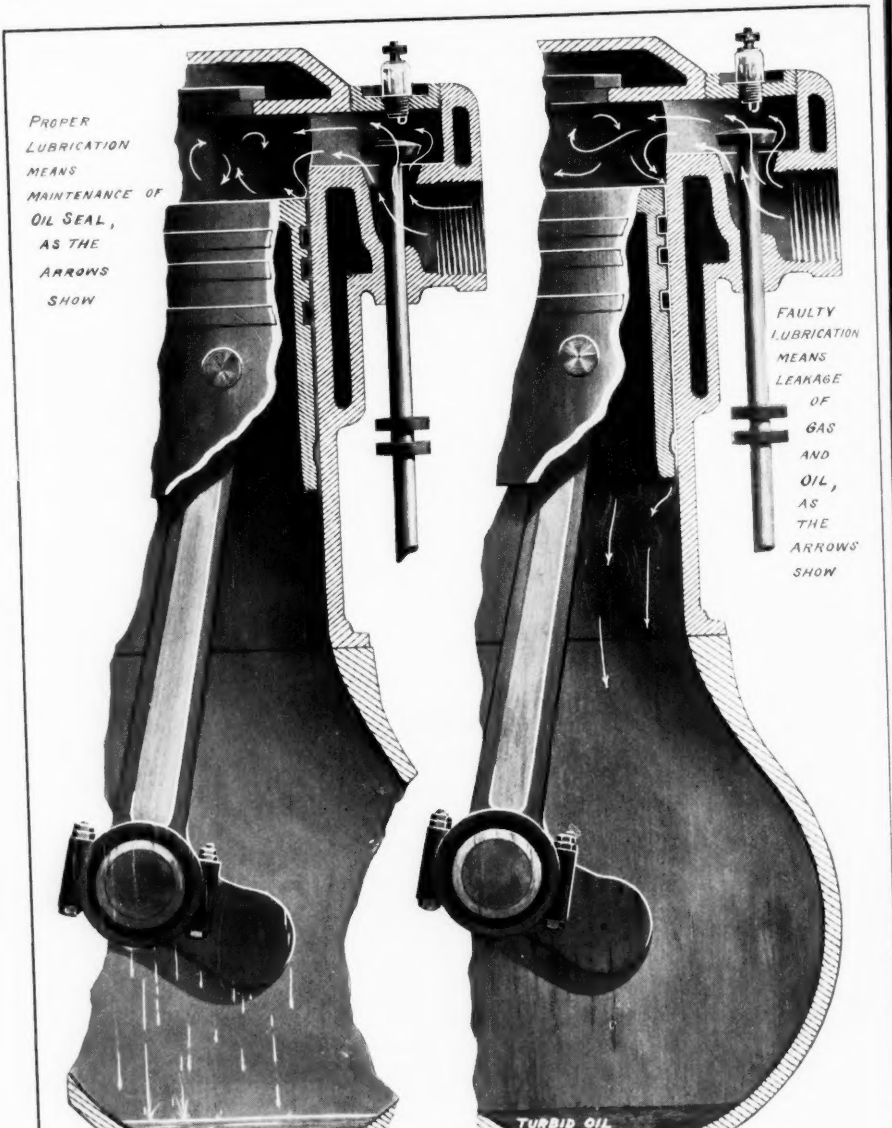
Inasmuch as most of the obvious trouble in connection with the lubrication of motor driven vehicles comes from the motor cylinders, this point should be considered first. The performance of the motor of any gasoline driven vehicle depends upon the maintenance of the compression, and the efficiency of the motor depends to a considerable degree upon keeping this at maximum point.

It is obvious, upon consideration, that it is practically impossible to fit the moving piston into the cylinder so closely as to secure a high compression without increasing the resistance or friction to such a point that it will absorb a considerable amount of power in turning over the motor without doing any useful work. During the suction or admission stroke, the admission valve is so arranged that it will not admit air into the cylinder as fast as the piston displaces it. This results in creating a partial vacuum which carries the gasoline and air mixture through the carbureter. This partial vacuum will at the same time carry the lubricating oil up past the piston rings into the compression chamber unless this oil is sufficiently tenacious to adhere to the cylinder walls.

The amount of lubricating oil which passes the rings and gets into the explosion chamber during the stroke is greater or less according to the fit of the piston rings in the cylinder and to the character of the lubricating oil. These same conditions—that is, the fit of the piston rings and the character of the lubricating oil—affect the compression, which can be secured and maintained during the next stroke. The compression which occurs during the next stroke is caused by the movement of the piston upward in the cylinder and this compression depends largely upon the close fit between the piston rings and the cylinder walls; upon the number of rings; and upon the way in which the oil will form a seal between the cylinder walls and the piston rings. When the cylinder is closed, the only loss of compression comes through the fit of the valves, poor mechanical fit of the piston rings or poor and faulty lubrication.

The lubricating oil may be indirectly the cause of poor mechanical fit of the valves and piston or rings on account of hard carbon being deposited thereon. Poor lubrication, even with a good oil, will result in a loss of compression without regard to the perfect mechanical fit of the piston rings. With good lubrication and an oil of the right character, the compression can be maintained even with worn out rings and a loose piston.

On the next stroke, the explosion of the mixture and the consequent expansion of the gases therefrom produces the power to drive the motor. Provided the carbureter is properly adjusted so that the mixture is in the right proportion for effective work,




If the seal between the piston rings and cylinder walls is good, the mixture will be compressed to a high degree. In order to maintain good compression in the cylinder, an oil must evidently be used which will adhere to the cylinder walls, filling the space between the piston rings and the cylinder walls. If there is a slight leakage on each compression stroke gasoline may seep into the crank case, making the oil absolutely unfit for further use.

**The effect of good and bad lubrication in an automobile engine**

the amount of power developed from the explosion is largely dependent upon the compression secured during the second stroke; the greater the compression secured during that stroke the greater will be the initial pressure at the time of explosion, and consequently the greater the force of explosion.

If the seal between the piston rings and cylinder walls is maintained perfectly, the mixture during the second stroke will be compressed to a high degree. At the same time, during the explosion or power stroke none of the force (which should be expended in driving the piston down) will be lost through leakage past the piston rings. Of the power developed by the motor, the percentage which can be used to drive the motor forward, is dependent not only upon the degree of compression, but also upon the way the compression is secured. In other words, in order to turn the power developed by the explosion and the expansion of the gas into useful work, it is not only necessary that the compression should be secured, but that it should be secured by proper means.

The troubles attendant upon poor compression in the cylinder are well known to most motorists. Under these conditions a motor is frequently unable to take a hill at all, and in any case the speeds must be changed in order to accomplish it. This is the case even where the same motor with good compression will not have the slightest difficulty in negotiating the same grade at top speed.

### Good Adhesion Necessary in Oil

It is, therefore, evident that in order to maintain the good compression in the cylinder and at the same time avoid excessive wear and tear, due to metal contact, it is necessary to have an oil which will adhere to the cylinder walls, filling the space between the piston rings and cylinder walls so that compression is secured and the metal surfaces are still kept apart. If the lubricating oil used is too light or is not of such a character as will provide this, the piston rings and the walls of the cylinder will come together so that there is excessive wear, resulting in a larger clearance at some points in the cylinder, and in a difficulty in securing as much compression as ought to be secured, and in a much more rapid replacement of parts in order to maintain a working condition at all.

It is, of course, possible to run a motor for a certain length of time on any kind of lubricating oil, and it may be months before the difference in lubricating oil will begin to show itself. Unfortunately, however, when the difficulty becomes obvious the damage is practically all done.

In this connection it may be stated that, while the different motors have different systems of lubrication to some extent, and while these different systems may require slightly different grades of oil, this is not true of all oils or of all the modifications of the systems. Practically all systems of lubrication in use can be divided into three general classes and combinations of these classes. They are—splash, force feed, and circulation systems—and the difference in the oil required for these different conditions of lubricating systems is merely a difference in body, due to the mechanical limitations, and not a difference in character. It is true that some of the oils on the market are so manufactured as to be suitable only for a limited number of conditions, and in such cases variations in motor and lubricating system design may require modifications in the character of the lubricant.

It is probable, however, that there are more grades of lubricating oil in use than the mechanical conditions would warrant, and the right character of oil is much more important than a specific grade.

## Changing the Oil in the Crank Case

For all systems of lubrication, and particularly with the splash system and the modifications thereof, it is very important to see that the lubricating oil in the crank case is changed a sufficient number of times, particularly if there is any leakage of the air mixture into the crank case during the compression stroke. It frequently happens that there is a slight leakage on each compression stroke sufficient to allow a certain amount of gasoline to get into the crank case, where it condenses in the lubricating oil, making the oil absolutely unfit for further use, and increasing the cylinder wear-and-tear out of all reason. Motors have frequently been run for 200 or 300 miles with lubricating oil in the crank which was absolutely useless, as far as preventing wear-and-tear was concerned, and which performed its only service in carrying away some of the frictional heat, so that there was no freezing of the engine.

In one case which came to the writer's notice, after the car had been standing for some time, a repair man opened the crank case, and lighting a match in order to examine something inside the case, was surprised at an explosion sufficient to seriously burn his hands and face. This explosion was undoubtedly due to the presence of gasoline in the lubricating oil in sufficient quantity and its evaporation into the surrounding atmosphere.

It is evident from a careful study of motor lubrication that the character of the lubricating oil and system not only have a direct bearing upon the wear and tear, but also upon the power developed and the consumption of the lubricating oil, and of these it is probable that the difference in power developed is alone sufficient to more than pay for any difference there may be in oil cost. It is, of course, obviously impossible for any man in the ordinary running of his car to test as thoroughly as advisable the effect of a lubricating oil. It is true that the effect of the oil in practical work on the road is the important effect, and if the motorist is given to careful and accurate recording, he can by cleaning his machine thoroughly, by putting in an exact quantity of oil, by running over a specified course, using a certain speed or gear change on the hills, seeing that the atmospheric conditions are as nearly as possible alike, and using the same gasoline in both cases, determine the effect of his lubricating oil closely and accurately. If he keeps his accounts fairly well and understands how much it costs for repairs and replacement to his car, he can determine without such testing whether there is any difference in the use of one oil over another, particularly in the replacements of spark plugs, regrinding of valves, and in the cleaning of cylinders, but in this case he obviously must cover a great deal longer time, and his decision will be correspondingly delayed.

As a matter of fact, the only feasible way for the motor owner to do in determining the value of different oils, is to confine his buying in the first place to one or other of the several well-known brands of oil which have, what the lawyer would term, prima facia evidence of their value, and then by keeping an accurate account of the power developed, of the consumption of oil, of the deterioration of oil in his crank case, of the carbon deposited on valves and spark plugs, thus determine the oil which is best suited (from the results it gives) to his machine and after such careful determination stick to the material which has shown itself to be the most adaptable and the best.

## The Importance of a Clean Lubricating System

The oil, however, is not to blame for all the misfortunes that happen to

his motor, nor is the owner absolved from his duties when he has bought an oil which he has every reason to believe is good for his machine. Some care is required in attending to the lubricating system so that the proper amount of oil, without dirt, is fed to the moving parts. In the splash system or in modifications of it, where the oil is carried from the crank case and returned without filtering, it is important that the crank case should be cleaned frequently, as the constant dipping of the connecting rods into the oil will keep any particles of grit suspended through the liquid, so that they are carried into the moving parts of the motor with a very speedy damage to such parts.

Furthermore, if the oil in passing through the system and back to the crank case tank is filtered, the filtering material should be removed and replaced frequently enough to insure its working at all times. The pipes which carry the oil to the various parts of the machine should be examined from time to time to see that they are clear and clean, and particularly in the winter time (unless the oil is of such a character that it will withstand practically any ordinary temperature without congealing), care should be taken that the pipes do not become clogged with congealed oil when the motor is standing.

The question of the lubricant, for the transmissions and differentials, the magneto, etc., as well as grease for the axle bearings, etc., is of just as much importance as the lubrication of the motor itself. The difficulty of determining the effect of such a lubricant is in this case, however, increased so that it is practically impossible for the motorist to determine, as between a number of fairly good lubricants, which are the best and most advantageous, and there is only one safe rule in this case, and that is, to buy the lubricant from the manufacturers who are supplying the motor owner with the most suitable cylinder lubricating oil.

Nothing gives less indication of its practical efficiency as lubricating oil. Color is not indicative, as two oils can be practically the same color and produce entirely different results from the standpoint of saving wear and tear, replacement and repair cost. Even the character of the crude has little bearing upon the value of the oil itself, and the only oil which is worth the motor owner's attention is the oil which proves in your machine that it will keep down the replacement of spark plugs, regrinding of valves, cleaning of the cylinders, keep up the power, and eliminate as far as possible deterioration in the crank case due to leakage from the cylinders. These are indications of its value which cannot be mistaken and which do not depend upon hypothetical determinations or tests, the value of which the motor owner has no means of judging.

## YOUR RESERVE POWER

ARE you prepared to handle extra work in your plant? Have you enough extra horsepower in reserve to do this work, or does your plant, plus frictional loss, require the full horsepower developed by your engines? In nine cases out of ten the percentage of lost power is too great. Texaco Lubricants have reduced this loss and added to the daily output in many plants. Their value lies in the fact that they really lubricate, every drop of them, and further, less is required to do even better work.

Let us furnish you with an efficiency man, an expert in lubricants; give him an opportunity to demonstrate to you wherein you can increase your output. We have solved difficult problems before and have come out ahead—we can solve yours.

## LUBRICATION *

THE lubrication of internal combustion engines has long been considered a difficult proposition and surrounded by more or less mystery. This has been due probably to a misunderstanding of the conditions in the combustion chambers.

Upon analysis, internal combustion engine lubrication does not seem either difficult or mysterious, and oils for this purpose can be and are prepared which will meet with entire success.

The first criterion of oils for this purpose has been high-flash and fire test, supposedly in order to withstand the high temperature of the combustion chamber. The points specified have usually been from 400° to 500° F., but it is manifestly impossible to expect that an oil of this test will not burn in a temperature variously estimated to be at 1,800° to 2,500° Fahrenheit.

With the temperatures mentioned above all oil entering the combustion chamber must necessarily be burned. Therefore the aim should be, first, to prevent excess oil getting to the combustion chamber and second, to obtain a clean-burning oil—that is, one depositing as little carbon as possible.

The quantity of oil passing by the piston rings to the combustion chamber is governed by the viscosity of the oil and the construction of the engine and its lubrication system. A gravity feed inherently permits the quantity of oil consumed to be accurately controlled. As the storage for this oil is usually set away from the engine and kept at low temperatures, a much different oil is required than with either the force feed or splash lubrication system. The storage for oil in the latter systems is generally the lower portion of the crank case. All oil is speedily warmed to a rather high temperature, with a consequent loss of viscosity. As in different makes of engines, there are differences in piston fit, number and size of rings and in heating of the oil, different viscosities are naturally needed for best results. The question of the most suitable viscosity is one to be settled by each manufacturer, although the personal equation of the operator has great bearing on the success to be obtained from the use of any oil.

A clean-burning oil must primarily be free from dirt and sediment, but aside from this there will be a certain amount of carbon deposit from the combustion. The amount of this deposit is usually determined by the carbon residue test, which consists in vaporizing and burning a certain amount of oil and measuring the percentage of carbon residue remaining after all the liquid has disappeared. All carbon deposit is not, however, due to excess or poor quality of oil. Excess of fuel or dirty fuel may cause much more carbon than it is possible to obtain from the lubricating oil.

The importance of high-flash and fire tests have been greatly overestimated. However, the oil should test sufficiently high to prevent undue loss by vaporization from the hot wall of the cylinder and piston. Engines, which are subject to cold weather use, should have an oil of low cold test, otherwise when the engine is first started the oil may be so stiff as not to splash or flow, and the engine be without lubrication for a considerable period. In general, it may be said that any good gas engine oil from a reputable manufacturer can be used successfully, although, depending on the condi-

*Extract from a paper by S. T. Dodd and B. H. Arnold, of the Engineering Department of the General Electric Company, entitled "Self-Propelled Railway Passenger Cars."

tions of operation and construction of the engine, certain oils can be used with a greater degree of satisfaction than others.

Thus far no specification or laboratory tests of oil have been found that are satisfactory for general use. The practical work-out test is by far the best means of determining the merits of a lubricating oil. When purchasing an oil its first cost should not be given undue importance. The cost of motor car operations is figured on a car mile basis, and the life of an oil—that is to say, the number of car miles per gallon or the cost per car mile—must be regarded as the only final criterion of the value of an oil.

## THE EFFECT OF MIXING OILS IN FORCED LUBRICATION SYSTEMS

By Lieutenant G. S. Bryan,
U. S. Navy*

TROUBLE has been experienced in the forced-lubrication systems of main engines and turbines in the Service from time to time, and it has frequently been suggested that this trouble might possibly be due to the mixing of two or more oils in the same system. In order to decide whether or not mixing oils had any harmful effect, the Bureau of Steam Engineering directed that a series of tests be undertaken at the Engineering Experiment Station at Annapolis with that end in view. The oils selected for the test were those that were submitted for the annual contract for 1913. In all there were eight oils, and of these five were paraffine base and three asphalt-base oils.

These oils were arranged in a list so that no two oils from the same company would be adjoining each other. Each one was then tested alone and in combination with the oils next adjoining it on the list. Thus:

Oil A alone.

Oil A in combination with oil B.

Oil B.

Oil B in combination with oil C.

Finally a mixture of all eight of the oils was tried.

The test was divided into three general parts:

(a) Test in oil-testing machine.

(b) Chemical examination for condition of refinement and determination of the physical constants before and after use in above machine.

(c) Test of oils mixed with steam and water.

A study of the oil-testing machines on the market failed to discover any one that was considered suitable for reproducing forced-lubrication conditions, and it was necessary to construct one at the Experiment Station.

The machine constructed has a steel journal, six inches long and one foot in circumference, turning in a regular white-metal bearing, and lubricated by forced feed. It is constructed so that it is possible to regulate the rubbing speed of the journal, the temperatures of the bearing and of the entering oil, the pressure on the bearing cap, and the pressure on the forced-lubrication system. The journal is driven by an electric motor, and the power used up in friction is measured electrically, thus giving the data necessary to figure the coefficient of friction.

In running tests it is usual to keep the bearing temperature constant at 135 degrees F., which is assumed as an average working heat. Five 100-minute runs are made with each oil

*From the May, 1914 issue of the *Journal of the American Society of Naval Engineers*.

to be tested, at a speed of 620 r.p.m., with the pressure varying from 30 to 150 pounds per square inch, and five are made with the pressure constant at 60 pounds per square inch, and the rubbing speed varying from 620 to 2,100 feet per minute. . . .

### Chemical Examination

Each oil and each mixture was examined both before and after use in the oil-testing machine, and it was hoped that this examination might throw some light on their behavior in service. As the oils were in the machine for such a short time, however, and the results obtained varied so much, it appeared that no conclusions could be drawn from a comparison of the oil before and after use. Samples of oil examined after use in the turbo-generator for thirty days have not shown any great change in their physical characteristics, except that they were generally darker in color. This has been the result found at other places, and it appears that it will take a long time for an oil to "wear out" in service.

The specific gravity, viscosity, flash and fire points and cold point are shown in Table 1.

**Table 1.—Physical Constants of Oils and Mixtures of Oils**

| Oil | Specific Gravity | Flash Point, Closed Cup, Degrees F. | Fire Point, Closed Cup, Degrees F. | Viscosity, 150 Deg. F | Cold Point, Degrees F. |
|---|---|---|---|---|---|
| A | .935 | 305 | 356 | 2.46 | −5 |
| A and B | .920 | 318 | 370 | 1.90 | −4 |
| B | .863 | 353 | 412 | 3.10 | 13 |
| B and C | .867 | 387 | 443 | 2.84 | 13 |
| C | .864 | 378 | 417 | 2.29 | 18 |
| C and D | .904 | 367 | 428 | 2.63 | 23 |
| D | .930 | 327 | 428 | 4.23 | 23 |
| D and E | .922 | 354 | 407 | 4.11 | 20 |
| E | .898 | 386 | 444 | 4.06 | 23 |
| E and F | .879 | 392 | 435 | 2.34 | 14 |
| F | .889 | 396 | 443 | 2.86 | 5 |
| F and G | .896 | 380 | 432 | 3.79 | 22 |
| G | .926 | 386 | 431 | 4.89 | 20 |
| G and H | .911 | 373 | 431 | 3.42 | 28 |
| H | .910 | 407 | 462 | 2.61 | 25 |
| H and A | .915 | 343 | 401 | 2.57 | 12 |
| A, B, C, D, E, F, G, and H | .898 | 369 | 426 | 2.55 | 19 |

The specific gravity of two oils that are mixed together is not necessarily the average of the two. This fact is explained by the manner in which the oils diffuse, giving a volume different from the sum of the volumes of the straight oils. An analogous example may be cited in a mixture of alcohol and water. If several oils of different specific gravities are poured gently together they settle out in layers in the order of their specific gravities, but if they are stirred well and then allowed to stand they do not settle out at all.

The specific gravity has no apparent

effect on the lubricating quality of an oil, and also no apparent effect on the rapidity with which the oils settle out. Theoretically it should have some effect, and it is probable that it does, but it is very small in comparison with the other factors that govern the separation. It is convenient as a means of identifying an oil.

In general, the flash and fire points of mixtures were about the average of those of the straight oils. A general average of the eight straight oils, the eight mixtures, and the mixture of all eight oils is as follows:

| | Flash Point, Closed Cup | Fire Point, Closed Cup |
|---|---|---|
| Average of eight straight oils | 361 | 421 |
| Average of eight mixtures (of two oils) | 367 | 421 |
| Mixture of all eight oils | 369 | 426 |

The cold point was changed but little, either by mixing the oils or by use in the machine. This quality would have little bearing on a turbine oil as long as it is within the limits found for all the oils tested.

The viscosity was determined with the Engler-Ubbelohde viscosimeter. It was found that the viscosity of a mixture generally lay between those of the straight oils, the exceptions being in the cases where the coefficient of friction was also less. The viscosity was determined at 90, 120, 150, 180, 212 and 300 degrees F. In the table only the viscosity at 150 degrees F. is shown. . . .

### Mixture with Steam and Water

Each oil and each mixture was given the test outlined below. Fifty cubic centimeters of the oil was mixed with each of the following:

(a) 50 cubic centimeters of distilled water at 65 degrees F.

(b) 50 cubic centimeters of Severn River water (340 grs. chlorine) at 65 degrees F.

(c) 50 cubic centimeters of boiling distilled water.

These mixtures were stirred in a pint commercial fruit jar for five minutes, and were then poured in graduated glass cylinders and allowed to settle out at room temperature (70 to 80 degrees F.), observations being made periodically of the total amount of oil and water that had not separated from the mixture.

Fifty cubic centimeters of oil and fifty cubic centimeters of distilled water were stirred in a steel-capped cylinder under 50 pounds steam pressure, and 100 cubic centimeters of the oil was stirred in the same cylinder under 300 pounds steam pressure, observations being taken as before.

In most cases the combinations showed percentages about the mean of those of the straight oils. In some cases the rate of separation appears to be a little slower, but different conditions of temperature under which the oils settled out would be enough to account for this slight variation and, from a practical point of view, no harmful results are indicated by this part of the test.

The exact nature and cause of this "separated matter" is not known. It occurs in various forms from a light, spongy flocculent material to a thick, creamy emulsion. The latter form is probably mostly a simple emulsion. Most of it will generally settle out into good oil and clear water if it is allowed to stand indefinitely, but some of the separated

matter never settles out. Whether it is waxy in character or is caused by sodium salts of napthenic acids, as some writers claim, there is no doubt that it should not be present. With the present knowledge at hand, about all that can be said is that some action, whether mechanical or chemical, occurs between the water and the oil when the mixture is thoroughly agitated, and that the quantity of this resultant matter, whatever it may be, depends upon the temperature of the oil and water when they are mixed, the degree of stirring to which they are subjected, and the temperature of the mixture while settling out.

Some of the matter formed at low temperatures is broken up into water and oil as the temperature is raised, and new combinations are formed. One oil (oil F), which emulsified very readily, was stirred for five minutes with equal volumes of water at different temperatures and allowed to settle out for twenty-four hours. At the end of that time, the following percentages of separated matter were found:

| Mixed at Temp. °F. | Percentage of Separated Matter |
|---|---|
| 51 | 1 |
| 65 | 3 |
| 83 | 5 |
| 120 | 26 |

This separated matter took the form of a thick jelly-like emulsion. The same character of emulsion was formed by bubbling steam through the oil for a few minutes. When the mixture was stirred under fifty pounds steam pressure, however, this emulsion disappeared, and a different kind of separated matter made its appearance.

The water that settles out from the mixtures with water and steam is always of a milky color with distilled water and a thicker creamy color with steam, being generally thicker with the more viscous oils. With salt water the water is fairly clear. By mixing salt water with the milky and creamy colored water referred to the latter may be cleared and slightly more separated matter precipitated.

## Conclusions

It is believed that the foregoing test has demonstrated that no harmful results are obtained due to mixing any or all of the oils tested. It is also believed that the eight oils tested are representative enough to cover the field of oils for forced lubrication, and that it may be safely assumed that the conclusions drawn from the test of the above oils will apply to all straight mineral oils for use in forced-lubrication systems.

# MOTOR EFFICIENCY

RECENTLY a very interesting test was conducted by an engineer of The Texas Company upon a two-ton truck owned and operated by a Philadelphia firm, for the purpose of demonstrating the results that can be obtained from the use of Texaco Motor Oils and Gasoline. Considerable valve trouble had been experienced on several trucks, and also the trucks seemed to consume an excessive amount of gasoline and lubricating oil per mile. It was agreed that a comparative test should be conducted to cover a period of four weeks, one week to be devoted to the test on each combination of products. At the conclusion of each test the motor was to be taken down, all carbon was to be removed, the valves ground, the crank case thoroughly cleaned out with gasoline, and the motor assembled and placed in first class condition for the next test. Each test was therefore to be conducted with all conditions as nearly the same as possible.

The test was conducted on a four

cylinder Garford motor, $4\frac{1}{2}'' \times 5\frac{1}{2}''$, equipped with Garford non-adjustable carburetor, Bosch Magneto, and jump spark ignition. The engine was lubricated by a force feed system, the oil being forced to the cranks through a hollow crank shaft by a small reciprocating oil pump. The wrist pin and cylinders were lubricated by means of a one-eight-inch brass pipe securely fastened to the connecting rod which carries the oil to the wrist pin from a small recess that is provided in the upper section of the crank boxes. The crank shaft bearings were lubricated by a splash system; the cam shaft, cams and bearings by force feed from the main oil pump. On the discharge side of the pump a one-eight-inch brass pipe led to the oil gauge which was fastened on the dash board of the truck. It was to carry a five-pound oil pressure on the gauge.

The load on this truck, which is in the furniture delivery service, making deliveries alternately on the main line and in Delaware County, varied daily, which naturally affected the mileage per gallon of gasoline. However, this condition could not be regulated; but taking the four weeks period into consideration, the average load carried per week on the above truck was approximately the same during each test. The mileage covered by the truck during the various tests was obtained from two meters in use on the truck, but unfortunately both were out of service temporarily during the first and third tests. On each occasion, the mileage was calculated from the average mileage per gallon of gasoline for the first three days of the test in each week.

On March 29th, this motor was taken down and all carbon removed from the pistons, cylinder heads, spark plugs and valves. The valves were ground in to a good seat, the crank case thoroughly cleaned out with gasoline, and the motor reassembled.

At the beginning of each test, an eight-ounce and a four-ounce sample of the motor oil to be used was taken. The eight-ounce sample was retained by us and the four-ounce sample retained by the other party to the test. At the conclusion of each test, also, similar samples were taken from the crank case and disposed of in the same manner. The results of the inspection of these samples will be used in the preparation of later papers on the subject of "Motor Efficiency."

The gasoline and oil consumption during all the tests was calculated in the following manner: the gasoline tank was filled at the beginning of each test, and filled each evening on the arrival of the truck at the garage, the gasoline being measured in a one-half gallon measure by the employees of the garage. The lubricating oil was measured in a quart measure, marked in one-half pint graduations, and in order to facilitate a close comparison, was converted into cubic centimeters. The lubricating oil consumption was calculated by placing one gallon of motor oil in the crank case of the motor before the test. This showed three-fourths of an inch high on the sight glass on the side of the crank case. On the arrival of the truck at the garage each evening, a sufficient amount of motor oil was added to that in the crank case to maintain the above level. The amount added daily was closely measured and at the conclusion of each test, the crank case was drained and the amount of oil which drained out closely measured and deducted from the total amount placed in the crank case. The motor oil of our competitors was handled exclusively by the garage men without any interferences or suggestions on our part. Texaco Motor Oil also was handled by the garage man, but under the direction of the testing engineer. The four tests were made as indicated by the charts below.

| Test No. | 1st Test | 2nd Test | 3rd Test | 4th Test |
|---|---|---|---|---|
| Time Element.. | From Mar. 29, to Apr. 5 | From Apr. 5, to 12 | From Apr. 12, to 18 | From Apr. 19, to 26 |
| Oil Used.... | Competitive Motor Oil | Competitive Motor Oil | Texaco Motor Oil, Special | Texaco Motor Oil, Special |
| Gas Used... | Texaco Gasoline | Competitive Gasoline | Competitive Gasoline | Texaco Gasoline |

## Test No. 1

COMPETITIVE MOTOR OIL AND TEXACO GASOLINE

| Date | Mileage | Gasoline Consumed | Lubricating Oil Consumed Cubic Centimeters | Texaco Gasoline Consumption Per Mile | Lubricating Oil Consumption Per Mile Cubic Centimeters |
|---|---|---|---|---|---|
| March 30th... | 40 | 10 gal. | 2838 | .25 gal. | 70.9 |
| March 31st... | 40 | 10 " | 2838 | .25 " | 70.9 |
| April 1st..... | 40 | 10 " | 2838 | .25 " | 70.9 |
| April 2nd.... | 36 | 9 " | 2838 | .25 " | 78.8 |
| April 3rd.... | 48 | 10 " | 2838 | .208 " | 59. |
| April 4th... | 36 | 8.75 " | 3174 | .243 " | 88. |
| Total...... | 240 | 57.75 " | 17364 | | |

Average mileage daily, 40 miles

Average gasoline consumption daily, 9.625 gallons

Average Lubricating Oil consumption daily, 2894 cubic centimeters

Average gasoline consumption per mile, .2418 gallons

Average Lubricating Oil consumption per mile, 73.08 cubic centimeters

| Color of Exhaust Daily | Time | Oil Gauge Pressure |
|---|---|---|
| Dark Oil Blue.......................... | 8 A.M. | 12 lbs. |
| Light Oil Blue.......................... | 11 " | 6 " |
| Faint Oil Blue.......................... | 1 P.M. | 2 " |
| Colorless.......................... | 3 " | 0 " |
| Colorless.......................... | 5 " | 0 " |

## Test No. 2

COMPETITIVE MOTOR OIL AND COMPETITIVE GASOLINE

| Date | Mileage | Gasoline Consumed | Lubricating Oil Consumed Cubic Centimeters | Competitive Gasoline Consumption Per Mile | Lubricating Oil Consumption Per Mile Cubic Centimeters |
|---|---|---|---|---|---|
| April 6th..... | 29.75 | 10. gal. | 2838 | .336 gal. | 95 |
| April 7th..... | 61 | 13 " | 3311 | .213 " | 54 |
| April 8th..... | 36.5 | 8 " | 2838 | .219 " | 77.7 |
| April 9th..... | 43 | 9 " | 2838 | .209 " | 66 |
| April 10th.... | 45 | 10 " | 2838 | .222 " | 63 |
| April 11th | 43 | 10.5 " | 2838 | .244 " | 66 |
| Total...... | 258.25 | 60.5 " | 17501 | | |

Average mileage daily, 43.04 miles
Average gasoline consumption daily, 10.80 gallons
Average Lubricating Oil consumption daily, 2916.8 cubic centimeters
Average gasoline consumption per mile, .2405 gallons
Average Lubricating Oil consumption per mile, 70.28 cubic centimeters

| Color of Exhaust | Time | Oil Gauge Pressure |
|---|---|---|
| Dark Oil Blue.......................... | 8 A.M. | 12 lbs. |
| Light Oil Blue.......................... | 11 " | 6 " |
| Faint Oil Blue.......................... | 1 P.M. | 2 " |
| Colorless.............................. | 3 " | 0 " |
| Colorless.............................. | 5 " | 0 " |

## Test No. 3

TEXACO MOTOR OIL SPECIAL AND COMPETITIVE GASOLINE

| Date | Mileage | Gasoline Consumed | Lubricating Oil Consumed Cubic Centimeters | Competitive Gasoline Consumption Per Mile | Lubricating Oil Consumption Per Mile Cubic Centimeters |
|---|---|---|---|---|---|
| April 13th.... | 54 | 10 gal. | 1893 | .185 gal. | 35 |
| April 14th.... | 33 | 6 " | 1893 | .181 " | 57 |
| April 15th.... | 43 | 8 " | 1893 | .186 " | 44 |
| April 16th.... | 59 | 11 " | 1893 | .184 " | 32 |
| April 17th.... | 43 | 8 " | 1420 | .184 " | 33 |
| April 18th.... | 54 | 10 " | 1420 | .184 " | 26 |
| Total...... | 286 | 53 " | 10412 | | |

Average mileage daily, 47.66 miles
Average gasoline consumption daily, 8.83 gallons
Average Lubricating Oil consumption daily, 1735.3 cubic centimeters
Average gasoline consumption per mile, .184 gallons
Average Lubricating Oil consumption per mile, 37.83 cubic centimeters

| Color of Exhaust | Time | Oil Gauge Pressure |
|---|---|---|
| Dark Oil Blue | 8 A.M. | 12 lbs. |
| Light Oil Blue | 11 " | 8 " |
| Light Oil Blue | 1 P.M. | 6 " |
| Light Oil Blue | 3 " | 4 " |
| Faint Oil Blue | 5 " | 4 " |

## Test No. 4

TEXACO MOTOR OIL SPECIAL AND TEXACO GASOLINE

| Date | Mileage | Gasoline Consumed | Lubricating Oil Consumed Cubic Centimeters | Texaco Gasoline Consumption Per Mile | Lubricating Oil Consumption Per Mile Cubic Centimeters |
|---|---|---|---|---|---|
| April 20th | 61 | 9 gal. | 1893 | .147 gal. | 31 |
| April 21st | 45 | 8 " | 1420 | .177 " | 31.5 |
| April 22nd | 59 | 9 " | 1893 | .1525 " | 32 |
| April 23rd | 48 | 8 " | 1656 | .166 " | 34 |
| April 24th | 45 | 8 " | 1420 | .177 " | 31.5 |
| April 25th | 41 | 10 " | 1656 | .243 " | 40 |
| Total | 299 | 52 " | 9938 | | |

Average mileage daily, 49.83 miles
Average gasoline consumption daily, 8.66 gallons
Average gasoline consumption, 52 gallons
Average Lubricating Oil consumption, 9938 cubic centimeters
Average Lubricating Oil consumption daily, 1656 cubic centimeters
Average mileage daily, 49.83 miles
Average gasoline consumption per mile, .177 gallons
Average Lubricating Oil consumption per mile, 33.3 cubic centimeters

| Color of Exhaust | Time | Oil Gauge Pressure |
|---|---|---|
| Dark Oil Blue | 8 A.M. | 8 lbs. |
| Light Oil Blue | 11 " | 6 " |
| Light Oil Blue | 1 P.M. | 4 " |
| Light Oil Blue | 3 " | 2 " |
| Faint Oil Blue | 5 " | 2 " |

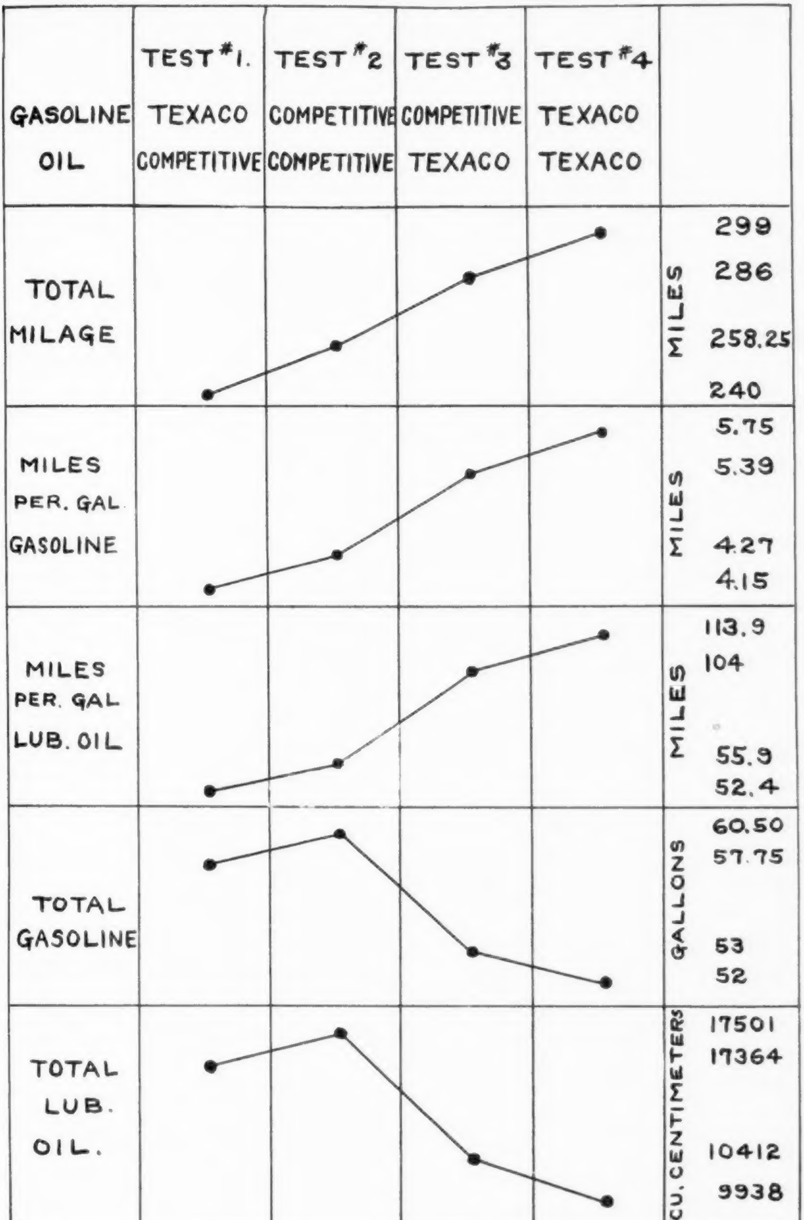



Chart showing efficiency of Texaco Lubricants and Gasoline. See table on page 22

## Comparison Sheet *

| Tests No. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Gasoline<br>Motor Oil | Texaco<br>Competitive | Competitive<br>Competitive | Competitive<br>Texaco | Texaco<br>Texaco |
| Total mileage | 240 | 258.25 | 286 | 299 |
| Total gasoline consumed | 57.75 gal. | 60.5 gal. | 53 gal. | 52 gal. |
| Total lubricating oil consumed | 17364 c.c. | 17501 c.c. | 10412 c.c. | 9938 c.c. |
| Average mileage daily | 40 | 43.04 | 47.66 | 49.83 |
| Average gasoline consumed daily | 9.625 gal. | 10.08 | 8.83 gal. | 8.66 gal. |
| Average lubricating oil consumed daily | 2894 c.c. | 2916.8 c.c. | 1735.3 c.c. | 1656 c.c. |
| Average gasoline consumption per mile | .2418 gal. | .2405 gal. | .184 gal. | .177 gal. |
| Average lubricating oil consumption per mile | 73.08 c.c. | 70.28 c.c. | 37.83 c.c. | 33.3 c.c. |
| Average miles per gal. of gasoline | 4.15 | 4.27 | 5.39 | 5.75 |
| Average miles per gal. of lubricating oil | 52.4 | 55.9 | 104 | 113.9 |

* See chart on page 21

The above table shows an increase per gallon of gasoline with the use of Texaco Motor Oil and Texaco Gasoline of 34.6 per cent., and an increase of mileage per gallon of Texaco Lubricating Oil of 117 per cent. On this two-ton truck with full load, approximately six miles per gallon of gasoline and one hundred and ten miles per gallon of lubricating oil was the feat accomplished by the Texaco products.

Attention should also be called to the carbon conditions found when the motor was taken down after each test. In the first case the carbon deposited on the cylinder heads and piston tops was hard and flinty and could not be removed with kerosene. There was also a gummy deposit on the valve stems. In the second test the conditions were practically the same, except that the deposit on the valve stems was harder. In the third test the conditions were much improved, the deposits being softer and partly responding to the kerosene test. In the fourth test, in which both Texaco Gasoline and Texaco Motor Oil were used, the carbon deposits on the cylinder heads and piston tops were soft and sooty and could be removed with kerosene. On the valve stems the coating was very thin and dry.

**Good luck to Lieutenant Porte on his flight. His selection of Texaco Motor Oil, Special, is not only lucky, but wise.**

## CYLINDER LUBRICATION

A CONCRETE example showing the efficiency of Texaco Pinnacle Cylinder Oil may not be out of place. A test was recently made on a 600 H.P. Simple Corliss engine, fitted with a Richardson mechanical lubricator and running under a steam pressure of one hundred and twenty-five pounds. When the Texaco Pinnacle Oil was placed in the lubricator it was at first regulated to feed exactly the same amount as of the competitive oil formerly used, which was one drop to each ten revolutions, or eight drops per minute. After a run of two hours it was apparent that more oil was being fed than was needed for complete lubrication, so the lubricator was regulated so as to feed one drop to every thirteen and one-third revolutions, or six drops per minute. This feed remained unchanged until the engine was shut down for Sunday. On the following Monday morning, after the valves began to work freely and smoothly, the feed was further reduced to four and one-half drops per minute, or one drop to eighteen revolutions. This feed remained unchanged, and the lubrication was sufficient and all valves worked freely and smoothly. Although the Texaco Pinnacle Cylinder Oil cost a few more cents per gallon than the competitive oil formerly used, the fact that only one-half as much of the Texaco Oil was used is a matter of the greatest importance. The competitive oil was used at the rate of one gallon in twenty-four hours. Texaco Pinnacle Oil was used at the rate of one-half gallon in twenty-four hours, and still gave perfect lubrication. The net result was a saving of thirty-three per cent. on the cost of the oil, and at the same time, better lubrication.

## TO THE MOTORIST

IT is our business to ease your troubles. Texaco Motor Oil offers the best remedy. It has a record of which we are especially proud. No matter where, on the speedway or through the open country, Texaco Motor Oils stand the test. In every case they give better compression, reduce wear on the moving parts, and eliminate carbon trouble. Possibly you don't realize how. Then write to us. Learn more about "The Care-Free Oil."

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The carbon deposit found on a cylinder determines one difference between a real good motor oil and a poor one. Oils may possess one or other of the necessary qualities for lubrication, but only the oil which in addition to its other qualities will burn up cleanly—which leaves your motor free from carbon deposit—is suitable for motor lubrication. Texaco Motor Oil burns up cleanly. Texaco Motor Oil has proven its worth to many enthusiastic motorists. Why not be one?

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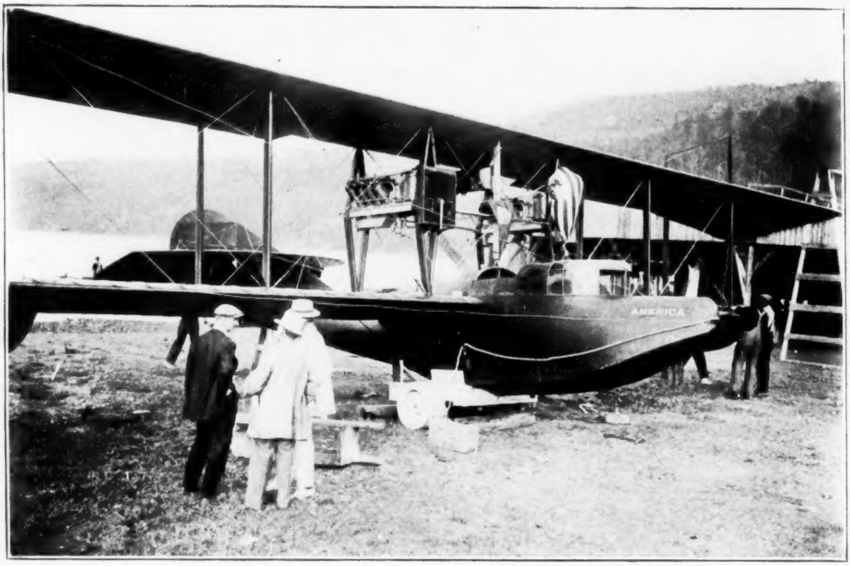
THIS little scrib is extracted from a daily report of one of our engineers. True it is short, but with all, the note of satisfaction is evident.

This is the kind of atmosphere created by Texaco.

"A competitive oil company tested some of their crusher oil here the other day, and the crushers ran hot and stuck up, burning a chunk out of a large drive belt. Mr. Nealon says there will be no more experiments pulled-off at this plant—Texaco is his middle name hence and forever."



Airboat, *America*, with two separate 100 h. p. Curtiss Motors that run with Texaco Motor Oil Special. Mr. Curtiss, the builder, standing on extreme left in foreground; Lieutenant Porte, the pilot, the tallest of the group of three.

## TRANSATLANTIC FLYER "AMERICA"

The lubrication of the motors for this flying boat caused the makers considerable anxiety as it was appreciated that the success of the proposed epoch-making flight absolutely depended upon the efficient and continuous operation of the motors.

Many oils were tried; at last TEXACO MOTOR OIL SPECIAL, made out of our Southwestern low gravity crudes, was adopted. On the acceptance trials, made possible by this oil, the motors ran 1250 revolutions for four hours, and never less than 1000 revolutions per minute for the entire 30 hours. The oil consumption for the two motors on this test was 10½ gallons.

Supplies of TEXACO MOTOR OIL SPECIAL have been sent to the starting station in Newfoundland, and to the supply stations in the Azores and Spain.

The Curtiss Company expresses the situation in this letter, which we copy.

## CURTISS MOTORS

Hammondsport, N. Y., June 24, 1914

THE TEXAS COMPANY,
New York City

Gentlemen :—

We have not received the invoice for the two barrels of *Texaco Motor Oil, Special*, sent on our order No. 2063, and received by us on June 15th. We think this must have gone astray and ask that you send a duplicate at once.

It will interest you to know that *the thirty-hour continuous run of the two trans-Atlantic motors mentioned in the papers several days ago was made possible by the use of your oil.* We also finished at one o'clock today the thirty-hour run on the second pair of these motors, and to say that the run was successful is putting it very mildly. *Texaco Oil was also used on this run, and as you will see by the order going forward under separate cover we think well of it.*

*We have further decided to use this oil on the trans-Atlantic flight.*

If you care to have a man here to witness the trials of the big machine, now is the time to send him along as it will be tried out for the next few days.

Yours truly,

THE CURTISS MOTOR COMPANY
[*Signed*] J. H. McNamara, Supt.